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Texas Metro Versus Nonmetro Variations in Cervical Cancer Preventative Measures

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Abstract

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by

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Abstract

Cervical cancer is a public health threat that can be eliminated with the use of preventative measures. Individuals who live in Texas's nonmetro areas are more likely than individuals who live in metro areas of Texas to be diagnosed with cervical cancer. In this study, the individual- and county-level factors in metro and nonmetro areas that facilitate or inhibit the receipt of cervical cancer preventative measures at multiple levels of influence were examined. The ecological model was used as the theoretical framework. Using secondary data from a national population health survey (n=1,303), the goal of this cross-sectional, quantitative study was to understand multilevel factors associated with cervical cancer preventative measures. The results of this study indicate that there is enough evidence to suggest an association between nonmetro status and cervical cancer preventative measures. Multinominal logistics regression analysis showed significant associations with individual-level factors but not with county-level factors for cervical cancer preventative measures. Specifically, the results indicate that individual-level factors (i.e., residing in a metro area, an individual's sexual identity, and household income) were associated with initiating the human papillomavirus (HPV) vaccine. Results also indicate that an individual's sexual identity, level of education, and health care coverage were associated with being current on pap testing. These findings will help practitioners understand the factors that need to be addressed to increase HPV vaccination and pap testing for individuals. Using the findings, practitioners will be able to develop individual-level interventions to increase cervical cancer preventative measures leading to positive social change.

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Section 1: Foundation of the Study and Literature Review

Cervical cancer occurs when cells in the cervix grow out of control (Centers for Disease Control and Prevention [CDC], 2019a). Early onset cervical cancer may not present signs or symptoms, but at advanced stages, cervical cancer may cause bleeding or discharge from the vagina (CDC, 2019a). The cervical cancer mortality rate has been steadily declining during the past century as early detection and prevention have been introduced. Cervical cancer preventative measures, the human papillomavirus (HPV) vaccine and pap test, are attributable to this decline in cervical cancer mortality (Sharma et al., 2020). In 1950, 9.16 women per 100,000 in the United States died from cervical cancer, but by the year 2017, the rate had fallen to 2.2 per 100,000 in the United States; however, in Texas, the rate is higher than the national average at 3 per 100,000 (National Center for Health Statistics, 2020).

Buskwofie et al. (2020) provided a review of the causes of disparities in cervical cancer incidence and mortality, highlighting geographic location as a source of the disparity and indicating individual factors, such as poor socioeconomic status, living in a rural community, and visiting a nongovernmental clinic, determined lower cervical cancer screening rates. The state of Texas has 254 counties spread out across 268,597 square miles (U.S. Census Bureau, 2019). The state is very diverse, with a mixture of metropolitan and nonmetropolitan areas. Rural counties experience a higher incidence rate of cervical cancer than urban counties at every stage (Yu et al., 2019). Moss et al. (2017) found that as urbanicity increased, cervical cancer incidence decreased. Despite these previous findings, further research is needed to understand the barriers and

facilitators to cervical cancer preventative measures in metro and nonmetro areas of Texas to design effective interventions to increase vaccination and screening.

Akinlotan et al. (2018) conducted a cross-sectional study of the 2014–2015 Texas Behavioral Risk Factor Surveillance System (BRFSS) to assess the combined effect of individual- and county-level characteristics on the use of cervical cancer screening tests in Texas. They found that the odds of timely pap testing was lower among women 50 and older, single, and those with low education and income. Akinlotan et al. also found a racial disparity, Black women that lived in communities with higher percentages of Hispanic populations were less likely to receive cervical cancer screening than those that did not live in a predominately Hispanic community. A limitation of the Akinlotan et al. study is that it did not examine the use of the HPV vaccine as an outcome measure.

In this cross-sectional, quantitative study, my aim was to understand the multilevel factors associated with cervical cancer preventative measures. I employed a similar methodology as Akinlotan et al. (2018), using the 2018 BRFSS data set and adding HPV vaccination as an outcome measure. In this study counties were differentiated based on their metro or nonmetro classification. The goal of this study was to determine if there is a difference in HPV vaccination and pap testing in these two distinct settings: metro and nonmetro areas of Texas. I intend for the study results to inform public health interventions to increase the HPV vaccination and pap testing in nonmetro areas in Texas. In Section 1, I discuss the problem under study, the purpose of the study, research question and hypotheses, theoretical foundation for the study, and nature of the study.

Problem Statement

Over the past 40 years, the United States has made tremendous strides in decreasing cervical cancer prevalence; however, disparities in cervical cancer incidence and mortality rates persist (Buskwofie et al., 2020). Moss et al. (2020) found that people who live in counties in the United States that experience persistent poverty are more likely to die from cancer than people in other counties. Poverty is more prevalent in nonmetro than metro areas (United States Department of Agriculture [USDA] Economic Research Service, 2020). When comparing nonmetro and metro areas in Texas, cancer registry data indicate that nonmetro areas had significantly higher cervical cancer mortality rates than metro countries, 3.5 versus 2.8 deaths per 100,000 (Texas Department of State Health Services [DSHS], 2020a). It is likely that this disparity can be attributed to the disparity in HPV vaccination and pap testing.

In 2019 in the United States, a little over half (54.2%) of adolescents 13–17 years old were considered up to date on the HPV vaccine (Elam-Evans et al., 2020). Those living in U.S. nonmetro areas had lower HPV vaccination up-to-date rates than those in metro areas (i.e., 47.3% vs. 57.1%; Elam-Evans et al., 2020). In Texas, the HPV completion rate for adolescents was even lower (at 48.4%) than in the United States (Elam-Evans et al., 2020). There has been no published analysis of Texas HPV vaccination rates that compare metro and nonmetro areas.

United States cervical cancer screening rates (82.9%) also remain below the Healthy People 2020 goal of 93% (Sabatino et al., 2021). In Texas, the rates are even lower, with only 76% of women 21–65 years old self-reporting having received a pap test

in the past 3 years (Texas Cancer Registry, 2019). In 2014, the U.S. pap testing rate was more prevalent in metro areas (65.5%) compared to nonmetro areas (34.5%; Crawford et al., 2016). Research is needed to examine the difference between metro and nonmetro areas in Texas's cervical cancer preventative measures.

Purpose of the Study

The purpose of this quantitative study was to identify what individual and county factors promote or inhibit the completion of HPV vaccine series and pap testing in metro and nonmetro areas in Texas. By understanding the individual and county factors that contribute to the variations in metro versus nonmetro areas, interventions can be designed to achieve higher rates of cervical cancer preventative measures and decrease the disparity. A literature review regarding barriers and facilitators to cervical cancer preventative measures revealed a significant gap in metro versus nonmetro areas reserach.

In this study, I combined secondary data that included individual-level variables, HPV vaccination status, and pap testing status with a secondary data set that included county-level variables. The individual-level variables of interest in this study included race and ethnic identity, sexual orientation, educational attainment, level of income, health insurance status, and geographic region. The county-level variables included the number of primary care physicians (PCP), the number of Federally Qualified Health Centers (FQHC), and geographic region.

Research Questions and Hypotheses

In this study, I explored the association between individual- and county-level characteristics on the completion of cervical cancer preventative measures and assessed whether counties in Texas classified as metro or nonmetro have statistically significant differences in the initiation of the HPV vaccine and pap testing. As such, the following research questions and hypotheses guided the study:

Research Question 1: What are the associations between individual characteristics (covariates; i.e., race/ethnicity, sexual orientation, education, income, and health insurance access) and the initiation of the HPV vaccine series (i.e., the dependent variable) in metro and nonmetro areas in Texas (i.e., the independent variable)?

$H_0$1: Based on 2018 BRFSS data, there are no statistically significant differences in metro versus nonmetro HPV vaccine initiation rates.

$H_1$1: Based on 2018 BRFSS data, there are statistically significant differences in metro versus nonmetro HPV vaccine initiation rates.

Research Question 2: What are the associations between county characteristics (covariates; i.e., PCP rate per 100,000 in county and number of FQHC per county) and the initiation of the HPV vaccine series (i.e., the dependent variable) in metro and nonmetro areas in Texas (i.e., the independent variable)?

$H_0$2: Based on 2018 BRFSS data, there are no statistically significant differences in metro versus nonmetro HPV vaccine initiation rates.

$H_1$2- Based on 2018 BRFSS data, there are statistically significant differences in metro versus nonmetro HPV vaccine initiation rates.

Research Question 3: What are the associations between individual characteristics (covariates; i.e., race/ethnicity, sexual orientation, education, level of income, and health insurance status) and pap testing (i.e., the dependent variable) in metro and nonmetro areas in Texas (i.e., the independent variable)?

$H_0$3: Based on 2018 BRFSS data, there are no statistically significant differences in metro versus nonmetro pap testing rates.

$H_1$3: Based on 2018 BRFSS data, there are statistically significant differences in metro versus nonmetro pap testing rates.

Research Question 4: What are the associations between county characteristics (covariates; i.e., PCP rate per 100,000 in county and number of FQHCs per county) and pap testing (i.e., the dependent variable) in metro and nonmetro areas in Texas (i.e., the independent variable)?

$H_0$4: Based on 2018 BRFSS data, there are no statistically significant differences in metro versus nonmetro pap testing rates.

$H_1$4: Based on 2018 BRFSS data, there are statistically significant differences in metro versus nonmetro pap testing rates.

Theoretical Framework

Theory is used to guide the development of public health interventions and understand the facilitators and barriers to adopting a health behavior (Grim & Hortz, 2017). In the ecological model and updated socio-ecological model, each level of influence and the interaction between the levels are described. For this study, I used the ecological perspective developed by Bronfenbrenner (1979) to guide the study design.

The ecological framework can be used to explain how completing cervical cancer preventive measures, HPV vaccination, and pap smear testing are interpreted and understood at various levels of influence. For this study, I assessed individual- and community-level factors. At the individual level, the individual-level characteristics of race and ethnic identity, sexual orientation, educational attainment, level of income, health insurance status, and geographic region related to initiating the HPV vaccine series and pap testing were examined. At the community level, I explored the county-level characteristics, number of PCPs number of FQHCs, and geographic region that promote the initiation of the HPV vaccine series and pap testing.

Nature of the Study

In this study, I employed a cross-sectional, quantitative research design. Using the match files command in IBM SPSS Version 25 (IBM, n.d.), two secondary data sets were joined at the county variable, the 2018 BRFSS, and the Area Health Resource File (AHRF). These data sets were used to examine individual and county variables on cervical cancer prevention measures.

The BRFSS is a national population-level health survey that collects information on a variety of health topics (CDC, 2019B). For this study, the questions that pertain to cervical cancer screening and HPV vaccination were the most pertinent (see CDC, 2019b). The AHRF includes data on health care professions, health facilities, population characteristics, economics, and environment at the county, state, and national levels (U.S. Health Resources and Services Administration, 2019). I linked the BRFSS data set by the county variable to the AHRF to assess county-level, independent variables. Combining

these data sets provided a composite profile for each county to examine the various factors related to HPV vaccination and pap testing.

Literature Review Related to Key Variables and Concepts

In the literature review, I discuss the selected articles relating to the completion of cervical cancer preventative measures. The keyword search terms used to locate literature were *cervical cancer, pap smear testing, HPV vaccination, race/ethnicity, sexual orientation, educational attainment, employment status, income level, geographic, rural/urban, metro and non-metro, primary care physicians, federally qualified health centers, medically underserved areas,* and *access to healthcare*. I found sources of literature in the PubMed and CINAHL & Medline Combined databases.

Cervical Cancer

Cervical cancer are epithelial tumors of the cervix and can be categorized into squamous, adenocarcinoma, and other epithelial tumors (Colombo et al., 2012). HPV is the most important etiologic factor in cervical cancer, accounting for 91% of cervical cancer cases (Senkomago et al., 2019). HPV infection does not always lead to cervical cancer. Kjær et al. (2010) found that women that develop an HPV infection had only a 26.7% probability of developing cervical cancer lesion within 12 years. However, almost all cervical cancers are attributed to an HPV infection (Senkomago et al., 2019). These persistent HPV infections typically occur during adolescents and young adulthood and progress to cervical cancer over a 10-year period (Chesson et al., 2014).

Women are at increased risk of developing cervical cancer if they have a history of high-risk HPV infection, the onset of sexual activity at a young age, multiple sexual

partners, smoke, have a weakened immune system, history of chlamydia infections, long term use of oral contraception, multiple pregnancies, and a diet low in fruits and vegetables (Olusola et al., 2019). It was estimated that 13,800 new cervical cancer cases would be diagnosed in the United States in 2020, and of those, 31% of women would die (Siegel et al., 2020). Texas was estimated to account for 1,410 cases (i.e., 10% of the new cervical cancer cases in the United States; Siegel et al., 2020). Cervical cancer incidence and mortality can be prevented with the HPV vaccine for primary prevention and pap smear testing for early detection and secondary prevention (Siegel et al., 2020).

Cervical Cancer Preventative Measures

Pap Testing

George Papanicolaou is credited with discovering cancer cells from a vaginal sample and the concept that a preinvasive stage precedes invasive carcinoma, noting that, if detected early, early-stage cervical cancer could be treated effectively (Shaw, 2000). Papanicolaou's' discovery and method of collecting cervical samples is referred to as the Pap smear test. Pap smear testing, or cervical cytology, has been a successful cancer screening test since the 1960s (Shaw, 2000).

Meggiolaro et al. (2016) conducted a systematic review and found that the pap test is a protective factor against cervical cancer. Pap testing is a highly accurate test for identifying precancerous lesions of the cervix. In reviewing eight randomized controlled trials, five cohort studies, and one individual participant data, the false-positive rates for pap testing ranged from 2.6% to 6.5%, indicating a sensitivity of 95.5%, meaning that

95.5% of the time the test is able to correctly identify patients with precancerous lesions of the cervix (Melnikow et al., 2018).

The U.S. Preventive Services Task Force (USPSTF; 2018) recommends screening for cervical cancer via the pap smear test for women between 21–29 years old every 3 years. For women aged 30–65, the USPSTF recommends pap smear testing every 3 years or every 5 years if done with HPV DNA testing. In 2020, the American Cancer Society updated its guidelines to reflect that women should begin cervical cancer screening at age 25, not 21 (Fontham el al., 2020). The primary testing method recommended by the American Cancer Society is HPV DNA testing every 5 years, with cotesting and cytology alone being acceptable where access to HPV DNA testing is not available (Fontham et al., 2020).

Factors Associated With Pap Testing

Individual Level Factors. In Bronfenbrenner's (1979) ecological model, individual-level factors are characteristics of the individual. The individual-level barriers and facilitators to screening that I explored in this study were (a) race and ethnic identity; (b) language, cultural barriers, and immigration status; (c) sexual orientation; (d) educational attainment; (e) employment and income; (f) access to health care; and (g) geography (see Adunlin et al., 2019; Fuzzell et al., 2021; Sabatino et al., 2021). These factors are not always mutually exclusive; they may intersect and play multiple roles in the promotion and hindrance of pap testing.

Race/Ethnicity. With close to 29 million people, Texas is racially and ethnically diverse, with non-Hispanic Whites comprising 41.2% of the population, non-Hispanic

Blacks making up 12.9% of the population, Hispanics accounting for 39.7% of the population, and non-Hispanic Asians making up 5.2% (U.S. Census Bureau, 2019). From 2012–2016, non-Hispanic Whites in Texas had a screening rate of 80%, compared to non-Hispanic Blacks at 78%, Hispanics at 75%, and Asians at 73% (Texas Cancer Registry, 2019). In studies analyzing cervical cancer screening rates, when controlling for other factors, the effect of race/ethnicity is often diminished or eliminated (Fuzzell et al., 2021).

Language, Cultural Barriers and Immigration Status. Among individuals with limited English proficiency, cervical cancer screening rates are often significantly lower in the United States (Ridgeway et al., 2020). Adunlin et al. (2019) conducted a systematic review of the barriers and facilitators to cervical cancer screening among immigrants in the United States and found that cultural norms and resource availability at the individual and system levels influence screening among immigrants. Immigrant screening rates are also impacted by lack of knowledge about cancer, limited English proficiency, embarrassment or fear of the test, and time away from work (Adunlin et al., 2019).

Sexual Orientation. Individuals assigned female sex at birth but who identify as lesbian, gay, bisexual, transgender, or queer face barriers to cervical cancer screening. Of individuals who identified as only having female sex partners, 46.6% self-reported receiving a pap test in the past year (Agénor et al., 2017). The National Transgender Survey found that only 27% of female to male (FTM) transgender men reported receiving a pap test in the past year (James et al., 2016). In a study conducted to examine cervical cancer screening behaviors among this population, Johnson et al. (2016) found that

stigma and lack of knowledge of the necessity of pap testing were barriers to being screened. In a systematic review, Connolly et al. (2020) reported that lack of knowledge on the part of both the individual and the provider contributed to low screening rates. Lack of knowledge consisted of cervical cancer risk and a misconception that you must be having sexual intercourse with a biological man to warrant the need for a pap test (Connolly et al., 2020; Johnson et al., 2016). For the FTM transgender population, providers were uncertain and lacked clarify of the guidelines (Gatos, 2018; Johnson et al., 2016).

To mitigate these barriers, facilitators, including health care environments, should be welcoming and inclusive (Johnson et al., 2016). Gatos (2018) advocated for transgender-specific guidelines that meet the needs of this population. Providers should be educated on appropriate gender minority care and explore patients' preferences around screening while avoiding assumptions (Connolly et al., 2020).

Educational Attainment. Damiani et al. (2015) conducted a systematic review and meta-analysis that confirmed and reinforced the evidence of inequalities in cervical cancer screening adherence according to educational level. In Texas, the majority (83.7%) of the population 25 and older have completed high school, and close to 30% have completed a bachelor's degree or higher. However, these rates are lower than the United States, which are 88% and 32.1%, respectively (U.S. Census Bureau, 2019). From 2012–2016, Texans with less than a high school education had the lowest screening rate at 70%, compared to college graduates with 87% being screened (Texas Cancer Registry, 2019).

Employment and Income. Employment status and income level are associated with pap testing rates (Murfin et al., 2020). Individuals employed and who have higher levels of income are more likely to be screened than those who are unemployed and have lower levels of income. In Texas, from 2012–2016, individuals making more than $50,000 had a screening rate of 87% compared to those earning less than $15,000 with a screening rate of 66% (Texas Cancer Registry, 2019). In a systematic review, Murfin et al. (2020) found limited research on the type of occupation and its effect on pap testing; however, they concluded that employment status is linked to receiving pap testing. Notwithstanding, Kim et al. (2016) found that individuals with only a part-time job have difficulties participating in cancer screening programs.

Access to Health Care. Individuals have a varying degree to access to health care. Uninsured women and those with public insurance are less likely to have had a pap test in the prior 3 years than those with private insurance (Bonafede et al., 2019). Lack of a usual source of care is also associated with low screening rates, with 25.5% of women with no regular health care clinician reporting that they had not received a pap test in the past 5 years compared to 11.4% of the general population (Benard et al., 2014).

Geography. Individuals living in rural areas are less likely to complete cervical cancer screening (Fuzzell et al., 2021). As a result, residing in a nonmetro area is associated with an increased cervical cancer incidence rate at every stage (Yu et al., 2019). Cost is a particular barrier among women in rural areas (Fuzzell et al., 2021).

Interpersonal-Level Factors. Interpersonal factors are interactions or relationships with other people. A provider recommendation for cervical cancer screening often influences screening uptake (Fuzzell et al., 2021). Patient-centered relationships with a trusted provider and clinical system may help overcome or reverse racial/ethnic disparities (Fuzzell et al., 2021). Examining interpersonal level factors was out of the scope of this study.

Community-Level Factors. Community-level factors refer to the relationship among organizations. Community-level factors consist of what is available in the community, which differs from community to community. In this study, the community was equated to the county level. I explored the following key community-level factors: (a) the number of PCPs, (b) the number of FQHCs, and (c) geographic region (see Fuzzell et al., 2021).

Primary Care Physicians. PCPs are responsible for providing preventive health care services, including pap testing to their patients. Access to primary care, however, remains a significant challenge in the United States with more than 6,000 areas in the nation being classified as primary care Health Professional Shortage Areas and several thousand areas and populations being classified as medically underserved (Streeter et al., 2020). With lower provider density in nonmetro areas, individuals residing there lack appropriate access to these services. Nonmetro areas also face higher provider turnover rates, which exacerbates access issues (Majid et al., 2019). Counties with a higher socioeconomic level and PCP density mediate the relationship between urbanicity and cervical cancer incidence (Moss et al., 2017).

FQHCs. Texas is home to 72 FQHCs that predominantly serve the uninsured and underinsured, of which 75% are located in metro areas (Health Resources and Services Administration, 2019). With only 25% of FQHCs serving nonmetro areas, this leaves many women without access to preventative services if they are uninsured or underinsured.

Geographic Region. Texas is the second-largest state by size and population, comprised of 254 counties spread out over 261,231 square miles (U.S. Census Bureau, 2019). There are 26 metropolitan statistical areas (MSAs) that encompass 82 counties, with the remaining 172 counties considered nonmetro (Texas DSHS, 2014). The population in MSAs is roughly 22 million compared to the population in non-metro areas of 1.4 million (Texas DSHS, 2014). As stated earlier, screening rates in Texas nonmetro areas are lower than in metro areas.

System-Level Factors. System- or policy-level factors are systematic in impacting the larger portion of the population. In the context of pap testing, system-level factors are policies at the organizational, state, or federal level that promote or inhibit women receiving a pap test. The Affordable Care Act Medicaid expansion is a system-level factor that has impacted increases in early detection of cancer and reductions in late-stage cancer incidence (Lin et al., 2021; Sabik et al., 2018). Texas has not expanded Medicaid; therefore, residents are not able to take advantage of these benefits. Examining system-level factors was out of the scope of this study.

HPV and the HPV Vaccine

HPV is a sexually transmitted infection, generally occurring after the first sexual activity (CDC, 2019a). Chesson et al. (2014) estimated that more than 80% of males and females with at least one sexual partner of the opposite sex will acquire an HPV infection by the age of 45. There are over 100 strains of HPV: oncogenic HPV types (mainly 16 and 18) cause cancer, and oncogenic HPV Types 6 and 11 cause anogenital warts (CDC, 2019a). HPV infections cause cancer of the cervix, anus, penis, vagina, vulvar, and oropharyngeal (Meites et al., 2019).

The HPV vaccine prevents HPV infection from four or nine strains of HPV, depending on the use of the quadrivalent or nonavalent vaccine (CDC, 2019a). The vaccine was first approved by the Food and Drug Administration in 2006, with the Advisory Committee on Immunization Practices then recommending the vaccine for use in females aged 9 to 26 to prevent cervical cancer (Markowitz et al., 2007). Since then, the Food and Drug Administration approval and Advisory Committee on Immunization Practices recommendation have expanded to include boys and girls aged 9 to 26 and those 27 to 45 years old with shared decision making (Meites et al., 2016; Meites et al., 2019).

Factors Associated with HPV Vaccination

Individual-Level Factors. In Bronfenbrenner's (1979) ecological model, individual-level factors are characteristics of the individual. In this study, I examined the following individual-level facilitators and barriers to HPV vaccination: (a) race and ethnic identity; (b) language, cultural barriers, and immigration status; (c) sexual

orientation; (d) educational attainment; (e) employment and income; (f) access to health care; and (g) geography.

Race/Ethnicity. Spencer et al. (2019) conducted a systematic review to characterize racial and ethnic differences in HPV vaccination. They found that there were no racial or ethnic differences in HPV vaccine initiation overall. When the authors refined the study to only studies that used provider-verified vaccination data, they found that minorities were 6.1% more likely than Whites to initiate HPV vaccination but were 8.6% less likely to complete the series (J. C. Spencer et al., 2019). Sriram and Ranganathan (2019) used provider verified data and found that Hispanic adolescents were 1.47 times more likely to be vaccinated for HPV than non-Hispanic White adolescents. It is significant to note that self-reported studies obscure the racial and ethnic differences in HPV vaccine initiation. For quality research, provider verified vaccination data should be used.

Language, Cultural barriers, and Immigration Status. Individuals that may have recently come to the United States have language or cultural barriers. These individuals are less likely to seek preventative health care or be able to access them (Khullar & Chokshi, 2019). In a systematic review of qualitative studies conducted by Wilson et al. (2018), they found that cultural norms, social norms, knowledge gaps, and lack of access to healthcare were among the primary reasons immigrant parents did not vaccinate their children against HPV. In a study of mothers with less than a high school education born outside the United States, Rodriguez et al. (2018) found that only 21% initiated the HPV vaccine for their daughters.

Sexual Orientation. Data is mixed on sexual orientation and HPV vaccination. In Fontenot et al. (2016), the researchers concluded that HPV vaccination rates might be even lower for high-risk populations, including lesbian, gay, bisexual, transgender, and queer individuals. Kang and Kim (2019) found that individuals that identified as lesbian or gay were less likely to complete the HPV vaccine series than heterosexual or bisexual individuals. However, Srivastav et al. (2019) found that individuals aged ≥ 18 who identify as gay/lesbian had higher rates of at least one dose of HPV vaccination than individuals identified as heterosexual, 28.6 versus 23.5. In addition, Solazzo et al. (2020) found that mostly heterosexual women were more likely to initiate HPV vaccination than completely heterosexual women with no same-sex partners.

Educational attainment. Murfin et al. (2020) conducted a systematic review and found that obtaining a high school or college education was associated with uptake of the HPV vaccination. Analyzing the National Health Interview Survey 2010 data, Laz et al. (2013) found education to be highly significant ($p < .01$) to initiation of HPV vaccination. Schülein et al. (2016) found a significant positive relationship between the highest levels of education and vaccination uptake compared to lowest educational levels. Parents with more education initiate the HPV vaccination at higher rates than their lower educated counterparts, however, more educated parents are also more likely to be vaccine hesitant (Szilagyi et al., 2020).

Employment and Income. Employment and income levels of ones' mother is a predictor of HPV vaccination. Sriram and Ranganathan (2019) analyzed the 2016 National Immunization Survey-Teen (NIS-Teen) data and found that adolescents from

low-income families were 1.21 times more likely to get vaccinated for HPV compared to higher-income families. The association between income and health care coverage has been well documented (Dickman et al., 2017). As low-income families are more likely to have Medicaid, and Medicaid managed care organizations emphasize primary and preventive care and measure performance (Rosenbaum & Morris, 2021), they are more likely to participate in quality improvement efforts to improve HPV vaccination rates.

Access to Health Care. The HPV vaccine is covered by public and private health insurance. For uninsured or underinsured adolescents, the HPV vaccine is covered by the Vaccines for Children program. In the United States, Merck, the vaccine manufacture, also has a program to provide the HPV vaccine at no or low cost to individuals (Kaiser Family Foundation, 2018). However, individuals need access to a PCP to be able to receive the two-dose vaccine. Boakye et al. (2018) found that individuals that had visited the doctor's office one to five times (*OR* 2.09; 1.56-2.81), or ≥ six times (*OR* 1.86; 1.48-2.34) within the last 12 months versus no visits were more likely to initiate and complete the HPV vaccine. The type of health care coverage is also associated with HPV vaccination, Sriram and Ranganathan (2019) found that adolescents covered by private health insurance were less likely to get vaccinated compared to adolescents with Medicaid.

Geography. Adolescents from the Northeastern regions of the United States were 1.62 times more likely to be vaccinated for HPV than those in the Southern regions (Sriram & Ranganathan, 2019). Swiecki-Sikora et al. (2019) found that HPV vaccination rates were lower among adolescents from small rural towns than from urban towns. Girls

in rural settings had lower odds (0.74, 95% CI: 0.60-0.91) of completing the HPV vaccine series than those that lived in urban settings. Boys in rural settings had lower odds of initiation (0.68, 95% CI: 0.52-0.88) and completion (0.63, 95% CI: 0.41-0.97) (Swiecki-Sikora et al., 2019). Conrey et al. (2020) analyzed sociodemographic and vaccination data using the 2017 NIS-Teen survey in oversampled counties in Texas. The findings suggest that a closer examination of regional differences across Texas is needed.

Interpersonal Level Factors.

Interpersonal factors are relationships and interactions people have with other people. In Bronfenbrenner (1979) ecological framework, interpersonal level factors are the microsystem, the relationships and interactions someone has with their immediate surroundings such as family, school, neighborhood, or environments. These interactions can promote or inhibit the uptake of HPV vaccination. A key interpersonal factor in the uptake of the HPV vaccination is a provider recommendation. Initiation among adolescents whose parents reported receiving a provider recommendation was 74.7% compared to 46.7% who did not receive a provider recommendation (Walker et al., 2019). Other interpersonal factors that can promote or inhibit the uptake of the HPV vaccine include social media, exposure to antivaxer campaigns, and ones' social connectedness (Ryan et al., 2021). Examining interpersonal level factors is out of the scope of this study.

Community Level Factors.

Community-level factors refer to the relationship among organizations. Bronfenbrenner (1979) describe the exosystem, or community, as the larger social system

in which one resides that may directly or indirectly influence ones development. Community-level factors consist of what is available in the community, which differ from community to community. To clearly define community, in this study, community will be equated to county level. Key community-level factors that will be explored include (one) the number of PCP (two) the number of FQHCs, and (three) geographic region.

Primary Care Physicians. As noted in Walker et al. (2019), the strongest predictor of receipt of HPV vaccination is a provider recommendation. Communities that are medically underserved lack access to PCP and pediatricians that can make this recommendation. Access to primary care among uninsured individuals may be limited due to the inadequate availability of PCP in the community (Hill et al., 2019).

Federally Qualified Health Centers. FQHCs are a safety net for individuals that are uninsured or underinsured. Lack of access to FQHCs can create a barrier to receiving the HPV vaccine. As noted previously, of the FQHCs in Texas, only 25% serve nonmetro areas, leaving a large population without access to preventative services. Expanding the use of FQHCs can ensure basic preventive care including vaccination to underserved communities (Taylor, 2019).

Geographic Region. The composition of the geographic region in which one resides also contributes to the promotion or inhibition of the uptake of the HPV vaccine. Henry et al. (2016) conducted a study that explored geographic factors that may be associated with HPV vaccine uptake and found that girls in high poverty communities

had higher HPV vaccine initiation compared with those in low poverty communities. Predominately Hispanic communities also had higher initiation rates.

System-Level Factors

System-level factors also contribute to the uptake of the HPV vaccine. Franco et al. (2019) analyzed how state-level characteristics relate to HPV vaccination rates in the U.S. and found that sex education policy, religiosity, and HPV vaccine mandates contributed to the HPV vaccine coverage rates. The researchers found Texas to be more conservative and highly religious, contributing to the low HPV vaccine coverage rates in 2016 (Franco et al., 2019). Examining system level factors are out of the scope of this study.

Relationship Between Pap Smear Screening and HPV Vaccination

Cervical cancer preventative measures, pap testing and HPV vaccination are associated at the intrapersonal and interpersonal level. At the intrapersonal level, Silver and Kobrin (2020) found that individuals that had received the HPV vaccine were more likely to complete pap testing. At the interpersonal level, Spencer et al. (2013) found that daughter's HPV vaccination uptake was associated with mother's pap testing and that if the mother did not participate in preventive health services, it was less likely that their daughters were vaccinated against HPV. The findings by Silver and Kobrin (2020) suggest that vaccinating well-screened populations will exacerbate the cervical cancer disparities.

Definitions

Access to health care: Refers to health insurance status.

Completion of HPV vaccination: Refers to receiving two shots of the series, if started before individuals 15 birthday, or three shots if the series started after individuals 15 birthday.

Educational attainment: Refers to the highest level of education an individual has completed.

Employment and income: Refers to if a respondent is currently employed and income level refers to individual earnings before expenses.

Initiation of HPV vaccination: Refers to receiving at least one shot of the series at any age.

Language: refers to the individuals performed first language they communicate in.

Metropolitan areas: Are characterized by a central urban area surrounded by other urban areas that work together economically or socially. The central urban area must have a population of at least 50,000 people with a combined regional population of 100,000.

Nonmetropolitan: Are all areas that do not meet the definition of a metropolitan area.

Race and ethnic identity: Are a social construct defined by the U.S. Office of Management and Budget. Individuals are categorized by race, White, Black or African American, Asian, Native Hawaiian or other pacific islander, American Indian or Alaska Native. Individuals can select more than one race on federal forms. Individuals are also asked to select if they are Hispanic or Latino, or not Hispanic or Latino (U.S. Census

Bureau, 2020). In this study, I used the following categories to describe individuals: White Not Hispanic, Black Not Hispanic, Asian Not Hispanic, and Hispanic.

Sexual orientation: Individuals self-reported identification as lesbian, gay, bisexual, transgender or queer.

Assumptions

The use of secondary data in this study requires some assumptions to be made. The first assumption, validity and reliability of self-reported data from the BRFSS data set on cervical cancer screening rates. The second assumption, that participants would answer honestly without bias to questionnaires. A third assumption, that the data collection protocols were followed, and accurate data were entered.

Scope and Delimitations

The study used a quantitative, cross-sectional study design. The study will use multiple datasets to analyze the individual and community-level barriers and facilitators to cervical cancer preventative measures, HPV vaccination and pap testing, in metro and nonmetro areas in Texas. Two main secondary datasets will be used, the 2018 BRFSS and AHRF, to assess if regional differences are statistically significant at the individual or community level.

Significance

The World Health Organization (WHO) released a global strategy to accelerate the elimination of cervical cancer and set goals for HPV vaccination coverage, screening with pap test, and treatment of cervical cancer (2020). The strategy underscores the importance of delivering targeted interventions to increase cervical cancer preventative

measures. Understanding the barriers and facilitators at multiple levels is imperative to designing effective interventions to reach the goals set out by the WHO.

As mentioned previously, this study's results will provide much-needed insight into the variations in HPV vaccination and pap testing in metro and nonmetro areas across Texas. Insights from this study should aid public health practitioners in designing effective interventions to increase cervical cancer preventative measures. This study's results can justify the need to increase scarce resources to target specific regions of the state. Through these efforts, Texas, a large, diverse state, can continue to reduce the rate of cervical cancer and eliminate this deadly disease as a public health threat.

This study addresses the gap in the literature regarding metro and non-metro facilitators and barriers to cervical cancer preventative measures at the individual and community level. By utilizing the information found in this study, interventionists will be able to target communities with high cervical cancer incidence rates and low screening and vaccination rates to address barriers and promote facilitators to HPV vaccination and screening.

Summary

Although there are preventative measures for cervical cancer, these measures are underutilized, causing cervical cancer incidence to persist. Geographic disparities exist in the uptake of HPV vaccination and pap testing. This section elucidates the various barriers and facilitators at multiple levels of influence on cervical cancer preventative measures. In Section 2, I describe the research design, data collection, and methodology that was used to conduct this study.

Section 2: Research Design and Data Collection

The purpose of this study was to determine metro and nonmetro facilitators and barriers to cervical cancer preventative measures at the individual and community level in Texas. In this study, I assessed if there is an association between individual- and county-level characteristics on the completion of cervical cancer preventative measures and whether counties in Texas classified as metro or nonmetro have statistically significant differences in the initiation of HPV vaccination and pap testing. This section includes a discussion of the research design and rationale, methodology, study population, sampling procedures, data analysis plan, threats to validity, ethical considerations, and access to secondary data.

Research Design and Rationale

There were two dependent variables in this quantitative study: the completion of the HPV vaccine series and completion of pap testing within the past 3 years. The independent variable was geographic region, either metro or nonmetro. The covariate variables at the individual level were race/ethnicity, sexual orientation, level of education, level of income, and health insurance status. The covariate variables at the community level were number of PCP and number of FQHCs.

I used a quantitative, cross-sectional study design with data from secondary data sets. Using the match file command in SPSS, two secondary data sets were joined at the county variable, the 2018 BRFSS, and the 2018–2019 AHRF. I used these data sets to examine county and individual variables on cervical cancer prevention measures (i.e., the dependent variable). Akinlotan et al. (2018) used a similar method of combining various

data sets to examine individual- and county-level characteristics of pap testing in Texas. In the current study, nonexperimental, cross-sectional, quantitative data were used to determine metro and nonmetro facilitators and barriers to cervical cancer preventative measures at the individual and community level in Texas. The advantages of using the BRFSS survey and AHRF data include ease of use, accessibility, cost, and efficiency.

Methodology

In this subsection, I describe how the study was conducted, the data collection methods, the study populations and techniques for sampling, the operationalization of variables, and ethical considerations.

Data Collection

In this study, I used publicly available secondary data from the 2018 BRFSS-Texas and 2018–2019 AHRF. The CDC collaborates with states to administer the BRFSS (CDC, 2019b). The BRFSS is a national population-level data set that collects data on health-related risk behaviors, chronic health conditions, and the use of preventive services (CDC, 2019b). The state of Texas administers the general BRFSS on an annual basis, the breast and cervical cancer screening module every other year, and the adult HPV module every year (CDC, 2019b). The BRFSS collects data on respondent demographics and the breast and cervical cancer screening module collects data on the completion of a pap test within the past 3 years. The U.S. Department of Health Resources and Services Administration (2020) Bureau of Health Workforce annually collects data from over 50 sources, with more than 6,000 variables related to health care access at the county level. In this study, I used the 2018–2019 AHRF to join the number

of PCP and number of FQHCs (i.e., covariates) and the county variable (i.e., the independent variable) in the 2018 BRFSS data sets. The data sets are publicly available.

Study Population

The target population in this study was females who had not had a hysterectomy aged 21 to 49 years old and living in Texas in 2017–2018. I selected this age group because it is the current recommended age group for HPV vaccination and cervical cancer screening by pap test by the USPSTF (2018).

Sampling Procedures

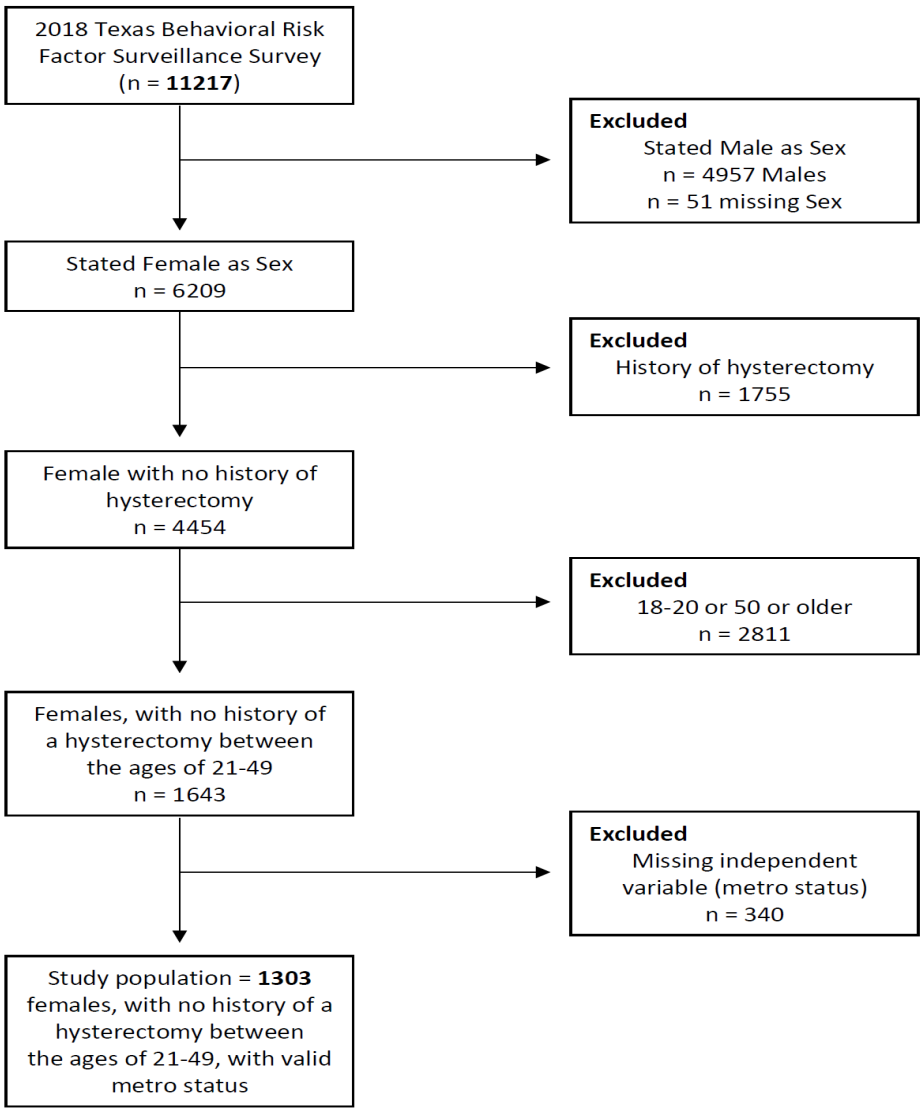
Texas began conducting the BRFSS in 1987 as a landline survey to collect data about health-related risk behaviors, chronic health conditions, and the use of preventive services by Texans (Texas DSHS, 2020b). In 2011, BRFSS began including cell phone users in the survey (Texas DSHS, 2020b). The BRFSS is used by public and private organizations to make decisions about funding and needed programs. The CDC provides a core questionnaire and optional modules, the state is also able to add questions (Texas DSHS, 2020b). During 2017–2018, Texas surveyed noninstitutionalized adults 18 years and older who reside in Texas, regardless of health status (Texas DSHS, 2020b). Texas administered the core questionnaire, which is done annually, the breast and cervical cancer module done every other year, and an adult HPV module which is done annually, in both English and Spanish (Texas DSHS, 2020b). The sample for this research study included all women respondents from the Texas BRFSS survey in 2018 who were between the ages of 21–49 because this is the age range that women would be eligible for both the cervical cancer screening and HPV vaccine.

I used G*Power, an open-sourced statistical power application, to calculate the sample size needed to make precise and accurate inferences (see Erdfelder et al., 2009). An alpha level of .05, 12 predictors in the regression model, a power of .80, and an effect size f^2 of .25 were used to calculate the sample size needed. An a priori power analysis to compute the required sample size determined that a sample size of 127 was needed to achieve statistically significant results.

Figure 1 shows the inclusion and exclusion criteria for the study. I removed individuals that stated they were male, had a history of a hysterectomy, were between the ages of 18–20 and 50 years of age and older, and cases with missing metro status area from the study population. The remaining 1,303 individuals were included in the sample selection. For this study, I used a sample size of 1,303 females aged between 21 and 49 years old, with no history of a hysterectomy, and living in Texas without missing data for metropolitan status.

Figure 1

Flow Diagram of Inclusion and Exclusion Criteria



Operationalization of Variables

To organize the variables used in this study, I created tables for each research question (see Appendices A–D).

Study Population

To refine the BRFSS data set to the study population, I used the following variables. Variable C08Q01: "What is your sex?" was a nominal categorical variable and filtered for only female respondents. Variable C08Q02: "What is your age?" was a continuous variable and filtered for only respondents aged 21–49. Variable C14Q17: "Have you had a hysterectomy?" was a nominal categorical variable and filtered for those individuals that responded "No." Cases that had missing data for metro status, MSA, were removed from the study population.

Independent Variable

The independent variable for this study was metropolitan status. The Variable C08Q09: "In what county do you currently live?" was a string variable and was matched with 2013 rural-urban continuum codes provided by the USDA Economic Research Service. The 2013 rural-urban continuum codes identify each county as metro or nonmetro (USDA Economic Research Service, 2013). I recoded the variable as metro or nonmetro, a nominal categorial variable. The 2018 BRFSS data set included this variable as MSA. This variable was used to further refine the study population to remove cases that had a missing value for MSA.

Dependent Variable

The dependent variables for this study included initiation of HPV vaccine and pap screening completed within 3 years. Initiation of HPV vaccine was defined as having at least one dose of the HPV vaccine. For this study, the nominal categorical Variable M17Q01: "Have you ever had an HPV vaccination?" responses were combined to create a new nominal categorical variable: initiated HPV vaccine.

The second dependent variable, up-to-date pap test, was defined as individuals aged 21–49 who have had a pap test within the past 3 years. For this study, I combined the nominal categorical Variable C14Q03: "Have you ever had a pap test?" and ordinal categorical Variable C14Q04: "How long has it been since you had your last pap test?" to create a new nominal categorical variable, up-to-date pap test.

Covariates

The covariates for the individual-level characteristics consisted of race/ethnicity, sexual orientation, level of education, level of income, and health insurance status. To measure race/ethnicity, I combined the nominal categorical Variable C08Q03: "Are you Hispanic, Latino/a, or Spanish origin?" and Variable C08Q04: "Which one of these groups would you say best represents your race?" to create a new nominal categorical variable for race/ethnicity. The new variable has four categories: White non-Hispanic, Black non-Hispanic, Hispanic, and Other. The nominal categorical Variable M21Q01: "Which of the following best represents how you think of yourself?" and M21Q02 "Do you consider yourself to be transgender?" were used for sexual orientation. The ordinal categorical Variable C08Q07: "What is the highest grade or year of school you

completed?" was used to measure level of education. I used the ordinal categorical Variable C08Q17: "What is your annual household income from all sources?" to measure level of income. The nominal categorical Variable C03Q01: "Do you have any kind of health care coverage…? was used to measure health insurance status.

The covariates for the community-level characteristics were derived from the AHRF database and included the rate of PCPs per 100,000 in the county and the number of FQHCs in the county. The rate of PCPs per 100,000 in the county and the number of FQHQs in the county are continuous levels of measurement, so I recoded these variables into an ordinal categorical variable for analysis.

Data Analysis Plan

The Texas DSHS (2020b) weights the BRFSS data with a method called ranking. They clean the data, ensure data-quality reporting, and release a data set for public use (Iachan et al., 2016). I used the public use data sets for analysis in the current study. Records that contained missing data for the independent variables were discarded. Missing data for the dependent variable and covariates were deleted listwise. I used IBM SPSS Version 25 to run descriptive statistics, with the mean as the measure of central tendency, as well as conduct bivariate and multivariable analysis. Refer to Appendices A–D for a list of data variables used to analyze each research question.

Research Questions

I analyzed the data for each research question with chi-square tests and multinomial logistic regression.

Research Question 1: What are the associations between individual characteristics (covariates; i.e., race/ethnicity, sexual orientation, education, income, and health insurance access) and the initiation of the HPV vaccine series (i.e., the dependent variable) in metro and nonmetro areas in Texas (i.e., the independent variable)?

Research Question 2: What are the associations between county characteristics (covariates; i.e., PCPs rate per 100,000 in county and number of FQHCs per county) and the initiation of the HPV vaccine series (i.e., the dependent variable) in metro and nonmetro areas in Texas (i.e., the independent variable)?

Research Question 3: What are the associations between individual characteristics (covariates; i.e., race/ethnicity, sexual orientation, education, level of income, and health insurance status) and pap testing (i.e., the dependent variable) in metro and nonmetro areas in Texas (i.e., the independent variable)?

Research Question 4: What are the associations between county characteristics (covariates; i.e., PCP rate per 100,000 in county and number of FQHCs per county) and pap testing (i.e., the dependent variable) in metro and nonmetro areas in Texas (i.e., the independent variable)?

Statistical Tests

Chi-Square

I conducted a chi-square test for all research questions to test if there is a relationship between the independent and dependent variables. The assumptions of the chi-square include (a) independent observations, (b) mutually exclusive, and (c) no frequencies less than five (Mchugh, 2013). A cross-tabulation table was also created to

evaluate the relationship between the independent and dependent variables. Additionally, I performed Cramer's *V* to examine the relationship and strength between the independent and dependent variables. A *p* value of 0.05 was used to determine the statistical significance.

Multinominal Logistic Regression

A multinominal logistic regression was conducted for all research questions to predict the probabilities of the covariate's role in the dependent variable. Assumptions must be met for multiple regression analysis, if these assumptions are not met, the results may be biased and not efficient (Allison, 1999). The first assumption is that the level of measurement of the dependent variable should be an interval-ratio measure, however, the use of dichotomous or dummy variables is sometimes appropriate (Warner, 2012). In this study, the dependent variables were coded as dichotomous. The second assumption is that the independent variables should be an interval-ratio or categorical variable (Frankfort-Nachmias & Leon-Guerrero, 2018). All independent variables are categorical in this study. Therefore, the study meets these two assumptions. The third assumption that should be met is mean independence or independence of observations. Mean independence refers to the independent variables that are unrelated or uncorrelated to random disturbance (Allison, 1999). This assumption was tested by conducting a Durbin-Watson statistic. For the dependent variable initiation of HPV vaccination, the Durbin-Watson statistics was 2.036 and for the dependent variable up to date pap testing the Durbin-Watson statistic was 2.019. A value of 2.0 means that there is no autocorrelation (Laerd Statistics, n.d.), therefore there is no autocorrelation and the assumption holds

true. The fourth and fifth assumption in multiple regression analysis is linearity and homoscedasticity. Linearity refers to the variables having a linear relationship. Homoscedasticity refers to the same variance at every X (Allison, 1999). Both linearity and homoscedasticity were tested by creating a simple scatterplot (Laerd Statistics, n.d.). The six assumption is uncorrelated disturbances. Correlated disturbances refer to two or more independent variables highly correlated with each other. If our independent variables are highly correlated, then we would not be able to distinguish which independent variable to attribute the effect to (Allison, 1999). Collinearity can be tested by conducting a collinearity tolerance test with a variance inflation factor (Laerd Statistics, n.d.). The final assumption is outliers in the data. Identifying outliers in the data can be completed by running descriptive statistics with boxplots (Allison, 1999; Laerd Statistics, n.d.). Outliers were removed from the dataset.

Threats to Validity

When conducting research there are several threats to validity that need to be accounted for. Validity refers to the being logically or factually sound (Drost, 2011). Measurement validity refers to measures really measuring what they are intended to measure (Drost, 2011). When conducting research there are several threats to validity that need to be recognized in order to minimize their impact. These threats include internal and external validity. Along similar concepts of validity, ethical considerations must also be considered when conducting research.

Internal Validity

Internal validity is the extent to which a study establishes a trustworthy cause and effect relationship (Drost, 2011). Threats to internal validity in this cross-sectional study consist of ambiguous temporal precedence, meaning we will not be able to assess cause and effect, only that there is a relationship (Shadish et al., 2002). Internal validity is measured by the elimination of bias, confounding, and random error, these were minimized by ensuring a robust representative sample size. In this study internal validity will be reflected in the rigor of the research design and statistical analysis.

Missing data creates imbalanced observations, cause biased estimates, and in extreme cases, can even lead to invalid conclusions. Records with missing data for the independent variable were removed from the study population, $n = 340$. Missing data for the dependent variable was excluded from analysis by listwise deletion (Kang, 2013), initiation of HPV vaccine, $n = 72$ and pap testing $n = 20$.

External Validity

External validity refers to applying the conclusions of a study outside the context of that study (Creswell & Creswell, 2018). In order to generalize the findings of the study across populations, the sample should be representative of the general population (Drost, 2011). A potential threat to external validity is using the BRFSS and ARHF data set for a new study. The questionnaires were not designed to answer the proposed research questions and therefore, I must consider whether a causal relationship obtained in one setting can be generalized to another (Drost, 2011). To minimize this threat in this study, a thorough review to ensure the accuracy and completeness of the data was completed,

and necessary alterations were made with the data. The results are explicit that the findings only relate to the sampled population.

Ethical Considerations

Ethical issues to be aware of in national survey data is confidentiality. There are federal laws in place to ensure that national survey data is kept confidential with penalties, including jail time and fines for those that disclose any confidential information (National Center for Health Statistics, 2019). Several steps were used to uphold the ethical procedures in this study. Institutional Review Board approval (09-09-21-1009974) was sought and received from Walden University. The study complied with all protection of human subject procedures. I received password protected data set, which I stored on a secure OneDrive personal vault, in which only I have access. All findings will be reported in an ethical manner, reporting on the evidence, data, findings, and conclusions.

Summary

In summary, it was stated in section 2 the research design (cross-sectional, quantitative), rationale and methodology of the study. The study determines metro and nonmetro facilitators and barriers to cervical cancer preventative measures at the individual and community level in Texas using the BRFSS and ARHF data sets. The study assesses if there is an association between individual and county-level characteristics on cervical cancer preventative measures. Assesses whether counties in Texas classified as metro or nonmetro have statistically significant differences in the initiation of HPV vaccine and pap testing. In Section 3, I will present the findings of the statistical analysis.

Section 3: Presentation of the Results and Findings

The purpose of this quantitative study was to determine metro and nonmetro facilitators and barriers to cervical cancer preventative measures at the individual and community level in Texas. Section 3 includes descriptive and inferential data analysis results on data collected from the 2018 Texas BRFSS and 2018 AHRF. In this section, I also provide evidence of an association between nonmetro status and cervical cancer preventative measures. These results will help practitioners develop interventions to reach individuals in nonmetro areas and ultimately increase cervical cancer preventative measures to eliminate cervical cancer as a public health threat.

Research Questions

Four research questions guided this study:

Research Question 1: What are the associations between individual characteristics (covariates; i.e., race/ethnicity, sexual orientation, education, income, and health insurance access) and the initiation of the HPV vaccine series (i.e., the dependent variable) in metro and nonmetro areas in Texas (i.e., the independent variable)?

Research Question 2: What are the associations between county characteristics (covariates; i.e., PCP rate per 100,000 in county and number of FQHCs per county) and the initiation of the HPV vaccine series (i.e., the dependent variable) in metro and nonmetro areas in Texas (i.e., the independent variable)?

Research Question 3: What are the associations between individual characteristics (covariates; i.e., race/ethnicity, sexual orientation, education, level of income, and

health insurance status) and pap testing (i.e., the dependent variable) in metro and nonmetro areas in Texas (i.e., the independent variable)?

Research Question 4: What are the associations between county characteristics (covariates; i.e., PCP rate per 100,000 in county and number of FQHCs per county) and pap testing (i.e., the dependent variable) in metro and nonmetro areas in Texas (i.e., the independent variable)?

Secondary Data Collection

Texas administers the BRFSS core questionnaire and HPV module annually and fields the breast and cervical cancer module every other year, in both English and Spanish (Texas DSHS, 2020b). During 2017–2018, Texas surveyed noninstitutionalized adults 18 years and older who reside in Texas, regardless of health status. The CDC collects the data, cleans it, and provides it to the state. The Texas DSHS weights the BRFSS data with a method called ranking. They clean the data, ensure data-quality reporting, create new variables from existing ones to collapse the responses, and release a data set for public use (Iachan et al., 2016). The Texas DSHS provides access to the public-use data set by email request. Once the Walden University Institutional Review Board approved the study, I submitted a request for the data set and received it from the Texas DSHS.

Results

Descriptive Analysis

The descriptive statistics of the study population are shown in Table 1. The total study population was 1,303, of which, 87% reside in metro areas and 13% reside in

nonmetro areas. The population consists of mostly White, non-Hispanic (46.8%) and Hispanic (38.2%) females. Individuals that identified as LGBTQ represented only 7.8% of the study population compared to 92.2% straight individuals. Educational attainment by the study population ranged from 10.1% with less than a high school education to 39.6% with a college degree. Household income had an even spread, with 33.5% having income of less than $25,000, 34.5% with income between $25,000 and $75,000, and 32.0% with income over $75,000. A majority of the study population (69.4%) had health insurance compared to 30.6% that did not.

The county-level variables consisted of the rate of PCP per 100,000 people in the county and the number of FQHCs in the county. The mean rate of PCPs across the counties was 72.6 and ranged from a low of 17.95 to a high of 120.16. A majority (45.2%) of the study population resided in a county with more than 76 PCPs per 100,000 people. The number of FQHCs in the county varied, with a mean of 24.1 FQHCs located in the county and a low of zero and a high of 101. Thirty-three percent of the study population resided in a county will less than seven FQHCs, whereas almost half (47.9%) resided in a county with more than nine.

Table 1

Descriptive Statistics of Characteristics of Study Population (N = *1,303*)

	Frequency	Percent
Region		
Metro	1,133	87.0
Nonmetro	170	13.0
Initiated human papillomavirus vaccination		
Yes	233	18.9
No	998	81.1
Up to date on pap testing		
Yes	1,003	78.2
No	280	21.8
Race/ethnicity		
White, non-Hispanic	600	46.8
Black, non-Hispanic	111	8.7
Hispanic	490	38.2
Other/multiracial, non-Hispanic	81	6.3
Sexual orientation		
Straight	1,100	92.2
LGBTQ	93	7.8
Educational attainment		
Less than high school	131	10.1
High school graduate	301	23.2
Some college	352	27.1
College graduate	515	39.6
Household income		
Less than $25,000	380	33.5
$25,000 to less than $75,000	392	34.5
$75,000+	364	32.0
Health care coverage		
Yes	900	69.4
No	397	30.6
Rate of PCPs		
Less than 55[a]	296	28.2
Between 55 and 75[a]	279	26.6
More than 75[a]	475	45.2
Number of FQHCs		
Less than 7	346	33.0
Between 7 and 9	201	19.1
More than 9	503	47.9

Note. a. per 100,000 people

Bivariate Chi-Square Analysis

As shown in Table 2, the proportion of the study population initiating the HPV vaccine who reside in metro areas is 91% compared to 9.0% living in nonmetro areas (*p* value < .05). The proportion of the study population initiating the HPV vaccine that identifies as straight is 84.3% compared to 15.7% who identify as LGBTQ (*p* value <.001). Initiating the HPV vaccine increased as level of education increased, with 5.6% for less than high school education compared to 40.3% in college graduates (*p* value < .098). As household income increased, the proportion of the study population that had initiated the HPV vaccine decreased (*p* value < .05). The rate of PCPs in the county was also significant (*p* value = .007). However, the number of FQHCs in the county was not (*p* value = .083).

Table 2 also displays the cross tabulation for up-to-date pap testing by the independent and covariates variables. The proportion of the study population up to date on pap testing who reside in metro areas is 88% compared to 12% living in nonmetro areas (*p* value < .05). The proportion of the study population up to date on pap testing that identifies as straight is 93.3% compared to 6.7% who identify as LGBTQ (*p* value = .006). Up to date on pap testing increased as level of education increased, with 8.5% for less than high school education compared to 43.4% in college graduates (*p* value < .001). As household income increased, the proportion of the study population that were up to date on pap testing also increased (*p* value < .001). The rate of PCPs and the number of FQHCs in the county was not significant on individuals being up to date with pap testing.

Table 2

Means of Cervical Cancer Preventative Measures Cross-Tabulation

Variable	Initiated HPV Vaccination *n* (%)	No HPV Vaccination *n* (%)	*p* value	Up to Date Pap Smear *n* (%)	Not Up to Date Pap Smear *n* (%)	*p* value
Metro	212 (91.0%)	857 (85.9%)		883 (88.0%)	233 (83.2%)	
Nonmetro	21 (9.0%)	141 (14.1%)	.038	120 (12.0%)	47 (16.8%)	.034
White, non-Hispanic	115 (49.8%)	458 (46.8%)		463 (47.0%)	126 (45.5%)	
Black, non-Hispanic	15 (6.5%)	92 (9.4%)		92 (9.3%)	17 (6.1%)	
Hispanic	86 (37.2%)	369 (37.7%)		374 (37.9%)	111 (40.1%)	
Other, non-Hispanic	15 (6.5%)	60 (6.1%)	.534	57 (5.8%)	23 (8.3%)	.166
Straight	177 (84.3%)	867 (94.0%)		869 (93.3%)	214 (88.1%)	
LGBTQ	33 (15.7%)	55 (6.0%)	.000	62 (6.7%)	29 (11.9%)	.006
Less than high school	13 (5.6%)	108 (10.9%)		85 (8.5%)	44 (15.9%)	
High school graduate	59 (25.3%)	223 (22.4%)		210 (21.0%)	85 (30.7%)	
Some college	67 (28.8%)	267 (26.8%)		272 (27.1%)	73 (26.4%)	
College graduate	94 (40.3%)	397 (39.9%)	.098	435 (43.4%)	75 (27.1%)	.000
Less than $25,000	77 (36.3%)	282 (32.5%)		273 (30.9%)	102 (42.9%)	
$25,000 - $75,000	81 (38.2%)	289 (33.3%)		302 (34.2%)	84 (35.3%)	
$75,000 +	54 (25.5%)	298 (34.3%)	.048	309 (35.0%)	52 (21.8%)	.000
Yes, health insurance	165 (70.8%)	690 (69.5%)		744 (74.4%)	145 (52.3%)	
No, health insurance	68 (29.2%)	303 (30.5%)	.691	256 (25.6%)	132 (47.7%)	.000
Less than 55 PCPs[a]	45 (23.7%)	226 (28.3%)		228 (28.2%)	63 (28.0%)	
Between 55 and 75 PCPs[a]	38 (20.0%)	223 (27.9%)		224 (27.7%)	54 (24.0%)	
More than 75 PCPs[a]	107 (56.3%)	350 (43.8%)	.007	356 (44.1%)	108 (48.0%)	.468
Less than 7 FQHCs	50 (26.3%)	271 (33.9%)		260 (32.2%)	81 (36.0%)	
Between 7 and 9 FQHCs	35 (18.4%)	153 (19.1%)		156 (19.3%)	39 (17.3%)	
More than 10 FQHCs	105 (55.3%)	375 (46.9%)	.083	392 (48.5%)	105 (46.7%)	.531

Note. a. per 100,000 people

I conducted chi-square tests of association to assess how each categorical independent variable or covariate aligned with the cervical cancer preventative measure (see Table 3). The results indicated that a significant association between nonmetro status, LGBTQ, level of income, rate of PCPs in county, and initiation of HPV vaccine. For the independent variable, I concluded that there is enough evidence to suggest an association between nonmetro status and initiation of HPV vaccine. I found an association between nonmetro status and initiated HPV vaccine ($\chi^2(2) > = 4.325$, $p < 0.05$). The effect size for this finding, Cramer's *V*, was small at .059.

Table 3

Chi-Square Test for Independence and Effect Size for Initiated HPV Vaccine

Variable	*n*	Chi-square value	*p* value	*df*	Cramer's *V*
Metro status	1,231	4.325	< .05	1	.059
Race/ethnicity	1,210	2.188	.534	3	.043
Sexual orientation	1,132	22.674	< .001	1	.142
Level of education	1,228	6.293	.098	3	.072
Level of income	1,081	6.061	< .05	2	.075
Insurance status	1,226	.158	.691	1	.011
Rate of PCPs	989	10.025	.007	2	.101
Number of FQHCs	989	4.970	.083	2	.071

Table 4 depicts the chi-square tests of association on up-to-date pap testing. The results indicated a significant association between nonmetro status, level of education, level of income, insurance status, and up-to-date pap testing. For the independent variable, I concluded that there is enough evidence to suggest an association between nonmetro status and up-to-date pap testing. An association was found between nonmetro status and up-to-date pap testing ($\chi^2(2) >= 4.495$, $p < 0.05$). The effect size for this finding, Cramer's *V*, was small at .059.

Table 4

Chi-Square Test for Independence and Effect Size for Up-to-Date Pap Testing

Variable	*n*	Chi-square value	*p* value	*df*	Cramer's *V*
Metro status	1,283	4.495	< .05	1	.059
Race/ethnicity	1,263	5.086	.166	3	.063
Sexual orientation	1,174	7.498	.006	1	.080
Level of education	1,279	35.266	< .001	3	.166
Level of income	1,122	18.126	< .001	2	.127
Insurance status	1,277	49.876	< .001	1	.198
Rate of PCPs	1,033	1.518	.468	2	.038
Number of FQHCs	1,033	1.67	.531	2	.035

Multinominal Logistic Regression

I conducted multinominal logistic regression analysis for all research questions to predict the probabilities of the covariate's role in the dependent variable. For Research Question 1, the model was a significant improvement in fit over a null model [$\chi^2(6) = 28.467$, $p < .001$]. The deviance chi-square and Pearson's chi-square test indicate that the model does fit the data well [$\chi^2(149) = 173.477$, $p = .083$] and [$\chi^2(149) = 163.749$, $p = .193$], respectively. Table 5 depicts the parameter estimates for the independent and covariates. The independent variable, metro status ($b = -.735$, s.e. = .300, $p = .014$) in the model showed that individuals residing in metro areas were more likely to initiative the HPV vaccine. The odds ratio of .480 indicates that for individuals residing in metro areas, the odds of initiating the HPV vaccine changed by a factor of .480. Using $\alpha = .05$ threshold, sexual and gender minority and level of income were also significant predictors in the model.

Table 5

Multinominal Regression Logistic Analysis – RQ1

Initiation of HPV Vaccine	*B*	Std. Error	Wald	*df*	Sig.	Exp(*B*)	95% Confidence Interval for Exp(*B*)	
							Lower Bound	Upper Bound
Metro area	-.735	.300	5.986	1	.014	.480	.266	.864
Race/ethnicity	-.016	.083	.035	1	.852	.985	.837	1.159
Sexual and gender minority	-.978	.253	14.929	1	.000	.376	.229	.618
Level of education	.117	.099	1.386	1	.239	1.124	.925	1.365
Household income	-.333	.125	7.109	1	.008	.717	.561	.916
Health care coverage	-.114	.202	.320	1	.572	.892	.601	1.324

Note. a. The reference category is: nonmetro area. b. This parameter is set to zero because it is redundant.

For Research Question 2, the model is a significant improvement in fit over a null model [$\chi^2(6) = 10.006$, $p < .019$]. The deviance chi-square test indicates that the model does not fit the data well [$\chi2(6) = 14.841$, $p = .022$], whereas the Pearson's chi-square does indicate good fit [$\chi2(6) = 11.060$, $p = .087$]. Table 6 depicts the parameter estimates for the independent and covariates. The independent variable, metro status ($b = -.812$, s.e. = .620, $p = .190$) in the model indicates that individuals residing in metro areas were more likely to initiative the HPV vaccine. The odds ratio of .444 indicates that for individuals residing in metro areas, the odds of initiating the HPV vaccine changed by a factor of .444. Using $\alpha = .05$ threshold, neither the rate of PCPs or the number of FQHCs in the county were shown to have significance.

Table 6

Multinominal Regression Logistic Analysis – RQ2

Initiation of HPV Vaccine							95% Confidence Interval for Exp(*B*)	
	B	Std. Error	Wald	*df*	Sig.	Exp(*B*)	Lower Bound	Upper Bound
Metro area	-.812	.620	1.717	1	.190	.444	.132	1.496
Rate of PCPs	.186	.113	2.740	1	.098	.966	.966	1.502
Number of FQHCs	.091	.107	.722	1	.396	.888	.888	1.350

Note. a. The reference category is: Non-Metro Area. b. This parameter is set to zero because it is redundant.

RQ3: The model is a significant improvement in fit over a null model [$\chi^2(6) = 55.702$, $p < .001$]. The Deviance chi-square test indicates that the model does not fit the data well [$\chi^2(150) = 187.121$, $p = .021$], whereas the Pearson's chi-square does indicate good fit [$\chi^2(150) = 161.509$, $p = .246$]. Table 7 depicts the parameter estimates for the

independent and covariates. The independent variable, metro status was not a significant predictor of up-to-date pap testing (b = -.338, s.e. = .229, p = .140). However, sexual and gender minority, level of education, and health care coverage were significant predictors in the model.

Table 7

Multinominal Regression Logistic Analysis – RQ3

Up to Date Pap Smear	*B*	Std. Error	Wald	*df*	Sig.	Exp(*B*)	95% Confidence Interval for Exp(*B*)	
							Lower Bound	Upper Bound
Metro area	-.338	.229	2.181	1	.140	.713	.455	1.117
Race/Ethnicity	.076	.083	.842	1	.359	1.079	.917	1.271
Sexual and Gender Minority	.668	.263	6.458	1	.011	1.951	1.165	3.267
Level of Education	.242	.094	6.689	1	.010	1.274	1.060	1.531
Household Income	.032	.126	.065	1	.798	1.033	.807	1.321
Health Care Coverage	-.846	.185	20.873	1	.000	.429	.298	.617

Note. a. The reference category is: Non-Metro Area. b. This parameter is set to zero because it is redundant.

RQ4: The model is not a significant improvement in fit over a null model [$\chi^2(6)$ = 2.225, p = .527]. The Deviance and Pearson's chi-square test indicate that the model does fit the data well [$\chi^2(6)$ = 2.969, p = .813] and [$\chi^2(6)$ = 2.774, p = .837], respectively. Table 8 depicts the parameter estimates for the independent and covariates. The independent variable, metro status was not a significant predictor of up-to-date pap testing (b = .033, s.e. = .400, p = .934).

Table 8

Multinominal Regression Logistic Analysis – RQ4

Up to Date Pap Smear	*B*	Std. Error	Wald	*df*	Sig.	Exp(*B*)	95% Confidence Interval for Exp(*B*) Lower Bound	Upper Bound
Metro area	.033	.400	.007	1	.934	1.034	.472	2.264
Rate of PCPs	-.125	.102	1.500	1	.221	.882	.722	1.078
Number of FQHCs	.131	.098	1.763	1	.184	1.140	.940	1.382

Note. a. The reference category is: Non-Metro Area. b. This parameter is set to zero because it is redundant.

Summary

The results of the study indicate nonmetro status, identifying as LGBTQ, higher level of income, low rate of PCPs in county are associated with initiation of HPV vaccine. Nonmetro status, low level of education, low level of income, and no health care coverage are associated with not being up-to-date pap testing. I can conclude that there is enough evidence to suggest an association between nonmetro status and cervical cancer preventative measures. In Section 4, I explore the interpretation of these findings, limitations, recommendations, and implications for social change.

Section 4: Application to Profession and Implications for Social Change

The purpose of this cross-sectional, quantitative study was to examine the associations between individual- and county-level factors, metro status, and cervical cancer preventative measures. I conducted several statistical analyses to determine if an association was present between the dependent, independent, and covariates. The results of these analyses were presented in Section 3. In this section, I discuss my interpretation of the findings, the limitations of the study, my recommendations for further research, and the implications for professional practice towards positive social change.

Interpretation of the Findings

The analyses of the 2018 Texas BRFSS and 2017–2018 AHRF data indicated that there were significant findings for individual-level factors but not county level factors. For individual-level factors, there were significant associations with individuals residing in metro areas, people that identify as straight, having lower household income, and the initiation of the HPV vaccination. Alternately, being up to date on pap testing was significantly associated with identifying as straight, having a higher level of education, and having health care coverage. There were no significant associations at the county level for either initiation of HPV vaccination or up-to-date pap testing.

Findings in the Literature

Metro Area

Consistent with the literature, I found that residing in a metro area was significantly associated with initiation of the HPV vaccination. Swiecki-Sikora et al. (2019) found that HPV vaccination rates were lower among adolescents from small, rural

towns than from urban towns. Despite lower rates of PCPs and lower numbers of FQHCs in nonmetro areas, no statistically significant association was found with the initiation of HPV vaccination in this study. Future studies should explore the level of knowledge of providers and the availability of the HPV vaccine at clinics in nonmetro areas. Contrary to the literature, I did not find a significant association between residing in a metro area and being up to date on pap testing. A previous study conducted by Fuzzell et al. (2021) reported that individuals living in rural areas are less likely to complete cervical cancer screening.

Health Care Coverage

Fuzzell et al. (2021) concluded that cost was a particular barrier among women in rural areas in completing cervical cancer screening. In this study, I found a significant association between health care coverage and being up to date on pap testing but not household income. The current study findings were consistent those of previous studies (i.e., Bonafede et al., 2019; Fuzzell et al., 2021; Hall et al., 2018) related to health care coverage and not metro status having a significant association with being up to date on pap testing.

Sexual Orientation

In this study, identifying as straight was a statistically significant association with cervical cancer preventative measures. Individuals assigned female sex at birth but who identify as LGBTQ were less likely to initiate the HPV vaccine or be up to date on pap testing in this study. Previous findings have been mixed concerning sexual orientation

and HPV vaccination status (Fontenot et al., 2016; Kang & Kim, 2019; Solazzo et al., 2020; Srivastav et al., 2019).

The 2018 BRFSS had a low response rate of individuals that identify as transgender, which limited data analysis. A few previous studies have explored transgender preventative health measures, such as the National Transgender Survey, which found that only 27% of FTM transgender men reported receiving a pap test in the past year (James et al., 2016). Future research is needed to explore the associations of this vulnerable population on cervical cancer preventative measures. National population-based surveys will need to be modified or developed that consider this population and phrase the questions appropriately. It is no longer acceptable to use a gender-based algorithm to determine which question blocks/modules an individual receives.

Household Income

An interesting finding in this study is that individuals with higher income levels are less likely to initiate the HPV vaccine but are more likely to be up to date on pap testing. Previous studies have reported mixed findings related to this association (Moss et al., 2015). However, the NIS-Teen data showed an inverse relationship between socioeconomic status and HPV vaccination rates, with higher socioeconomic status associated with lower HPV vaccination initiation and completion rates (Walker et al., 2018). Future studies should explore this phenomenon to understand the psychosocial properties of individuals' health care decisions and determine why individuals with higher incomes are more likely to use secondary prevention methods (i.e. pap testing) versus primary prevention methods (i.e. HPV vaccination).

Level of Education

Concurrent with the literature (i.e., Damiani et al., 2015), I found an association between level of education and up-to-date pap testing status but not HPV vaccination status. A previous study indicated that Texans with less than a high school education had the lowest screening rate at 70% compared to college graduates with 87% being screened (Texas Cancer Registry, 2019). In the current study, I found no association between level of education and initiation of HPV vaccination. However, previous studies have found that there is an association (Laz et al., 2013; Murfin et al., 2020; Schülein et al., 2016).

Parents with more education initiate the HPV vaccination at higher rates than their lower educated counterparts; however, more educated parents are also more likely to be vaccine hesitant (Szilagyi et al., 2020). Future studies should explore vaccine hesitancy and ultimate uptake among more highly educated individuals and parents.

Analyzing and Interpreting the Findings in Context

Utilizing the socio-ecological model in this study to explain the associations between individual- and county-level factors allowed for a more in-depth understanding of the facilitators and barriers for cervical cancer preventative measures. The framework helped explain the interaction between these levels. In this study, I found significant findings for individual-level factors but not county-level factors.

The results of this study indicated that individual-level factors (i.e., residing in a metro area, an individual's sexual identity, and an individual's household income) were associated with initiating the HPV vaccine. The results also indicated that an individual's sexual identity, level of education, and health care coverage were associated with being

up to date on pap testing. Individual-level factors are characteristics of the individual and correspond to the intrapersonal level in the socio-ecological model.

The results of this study also indicated that none of the county- or community-level factors (i.e., rate of PCPs and number of FQHCs) were associated with initiating the HPV vaccine and pap testing. Community-level factors refer to the relationship among organizations or the larger social system in which an individual resides in that may directly or indirectly influence their development. Future studies should explore additional county-level variables that could explain initiating the HPV vaccine and up-to-date pap testing.

Limitations of the Study

The BRFSS is a self-reported, population-based survey that inherently has limitations, including participant recall and the inability to verify the data with medical records. Unscreened women tend to overreport having a pap test, but screened women accurately report their screening (Anderson et al., 2019). The results of this study cannot be generalized to the entire U.S. population because the sample population only represents women living in Texas during the survey period.

Another limitation with using a population-based survey is an ecological and reductionist fallacy. An ecological fallacy arises when an inference is made about an individual based on aggregate data for a group (Portnov et al., 2007). A counter limitation is a reductionist fallacy. A reductionist fallacy is when inferences are made about group processes derived from individual-level data (Portnov el al., 2007). In this study, I used a

population-based survey to make assumptions about group behavior based on an individual characterstic.

Another limitation of this study is only examining the individual- and county-level factors. Exploring interpersonal- and system-level factors would add to the facilitators and barriers in cervical cancer preventative measures. Future studies should include variables from all levels of the socio-ecological model.

Recommendations

Additional research is warranted to further explore barriers and facilitators at all levels of the ecological frameworks. This study was limited to the individual and county levels; therefore, future studies should include variables at all levels of the socio-ecological model. In this study, no county-level variables were associated with the initiation of the HPV vaccine and up-to-date pap testing; therefore, I recommend that future studies explore additional county-level variables to understand the facilitatiors and barriers at a county level.

The results of this study indicated that individual-level factors (i.e., residing in a metro area, an individual's sexual identity, and an individual's household income) were associated with initiating the HPV vaccine. The results also indicated that an individual's sexual identity, level of education, and health care coverage were associated with being up to date on pap testing. Future research should explore vulnerable populations that do not identify as straight and higher income parents' perspective on HPV vaccination versus pap testing. If possible, provider-verified vaccination and screening data should be used.

Based on the findings of this study, I recommend interventions be developed and tailored to reach populations with low vaccination and pap testing rates. The findings in this study suggest that people residing in nonmetro areas, sexual and gender minorities, individuals with a higher income (for targeted HPV vaccination), individuals with lower education, and individuals with no health care coverage would be target populations of interest. Designing multilevel, multicomponenet interventions to increase HPV vaccination and cervical cancer screening rates in these populations is warranted based on the findings of this study.

Implications for Professional Practice and Social Change

In this study, I examined associations between individual- and county-level factors, metro status, and cervical cancer preventative measures. Understanding the facilitators and barriers to cervical cancer preventative measures can help practitioners develop interventions to increase the initiation of the HPV vaccination and pap testing.

Professional Practice

The findings from this study can aid and stimulate practitioners to develop interventions to address individuals that identify as LGBTQ for both the initiation of the HPV vaccine and pap testing. To address the paradox of high-income individuals' lack of HPV vaccination but being up to date on pap testing, public health practitioners should develop strategies to promote primary prevention (i.e., the HPV vaccine) as just as, if not more, protective than secondary prevention (i.e., pap testing).

Social Change

Having a better understanding of the barriers and facilitators to cervical cancer preventative measures in metro and nonmetro areas in Texas can lead to positive social change. Recognizing the factors and developing interventions to address those factors to increase HPV vaccination and pap testing for individuals can aid in reaching the Healthy People 2030 goals of 80% of age-eligible population receiving all recommended doses of the HPV vaccination and 93% of age-eligible women receiving on-time cervical cancer screening. Meeting the Healthy People goals are imperative to eliminating cervical cancer as a public health threat.

Conclusion

The purpose of this cross-sectional, quantitative study was to examine the associations between individual- and county-level factors, metro status, and cervical cancer preventative measures. Multinominal logistics regression analysis results showed that there were significant associations with individual-level factors but not with county-level factors for cervical cancer preventative measures. Specifically, the results of this study indicated that individual-level factors (i.e., residing in a metro area, an individual's sexual identity, and an individual's household income) were associated with initiating the HPV vaccine. The results also indicated that an individual's sexual identity, level of education, and health care coverage were associated with being up to date on pap testing. Future studies should explore variables at all levels of the socio-ecological model to fully understand the barriers and facilitators to cervical cancer preventative measures.

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Appendix A: Research Question 1 Data Variables

Dataset	Variable	Question	Response	Type
2018 BRFSS-Texas	SEX	What is your sex?	1 Male 2 Female	Defines study population
2018 BRFSS-Texas	AGE	What is your age?	_ _ Age in years (18-99) 7 Don't know/Not sure 9 Refused	Defines study population
2018 BRFSS-Texas	C14Q07	*Have you had a hysterectomy?*	1 Yes 2 No 7 Don't know/Not sure 9 Refused	Defines study population
Create New	Created from C08Q09	Metro Status	1 Metro 2 Non-Metro	Independent Variable
2018 BRFSS-Texas	M17Q01	Have you ever had an HPV vaccination?	1 Yes 2 No	Dependent Variable
2018 BRFSS-TexAS	Raceeth2	Race/Ethnicity	1 White Non-Hispanic 2 Black Non-Hispanic 3 Hispanic 4 Other	Covariate
2018 BRFSS-Texas	Created from M21Q01 and M21Q02	Sexual and Minority Gender	1 LGBT 2 non-LGBT	Covariate
2018 BRFSS-Texas	C08Q07	What is the highest grade or year of school you completed?	1 Less than high school 2 High school graduate 3 Some college 4 College graduate	Covariate
2018 BRFSS-Texas	C08Q17	What is your annual household income from all sources?	1 Less than $25,000 2 $25,000 to less than $75,000 3 $75,000+	Covariate
2018 BRFSS-Texas	C03Q01	Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, government plans such as Medicare, or Indian Health Service?	1 Yes 2 No 7 Don't know/Not sure 9 Refused	Covariate

Appendix B: Research Question 2 Data Variables

Dataset	Variable	Question	Response	Type
2018 BRFSS-Texas	SEX	What is your sex?	1 Male 2 Female	Defines study population
2018 BRFSS-Texas	AGE	What is your age?	_ _ Age in years (18-99) 7 Don't know/Not sure 9 Refused	Defines study population
2018 BRFSS-Texas	C14Q07	*Have you had a hysterectomy?*	1 Yes 2 No 7 Don't know/Not sure 9 Refused	Defines study population
2018 BRFSS-Texas	Created from C08Q09	Metro Status	1 Metro 2 Non-Metro	Independent Variable
2018 BRFSS-Texas	M17Q01	Have you ever had an HPV vaccination?	1 Yes 2 No	Dependent Variable
2018-2019 AHRF	PCPgroup	County Rate per 100,000	1 less than 55 per 100,000 people 2 between 55 and 75 per 100,000 people 3 more than 75 per 100,000 people	Covariate
2018-2019 AHRF	FQHCgroup	Number of FQHC per County	1 less than 7 2 between 7 and 9 3 more than 9	Covariate

Appendix C: Research Question 3 Data Variables

Dataset	Variable	Question	Response	Type
2018 BRFSS-Texas	SEX	What is your sex?	1 Male 2 Female	Defines study population
2018 BRFSS-Texas	AGE	What is your age?	_ _ Age in years (18-99) 7 Don't know/Not sure 9 Refused	Defines study population
2018 BRFSS-Texas	C14Q07	*Have you had a hysterectomy?*	1 Yes 2 No 7 Don't know/Not sure 9 Refused	Defines study population
2018 BRFSS-Texas	Created from C08Q09	Metro Status	1 Metro 2 Non-Metro	Independent Variable
2018 BRFSS-Texas	From C14Q03 and C14Q04	*Pap Test within past 3 years*	1 Yes 2 No	Dependent Variable
2018 BRFSS-TexAS	Raceeth2	Race/Ethnicity	1 White Non-Hispanic 2 Black Non-Hispanic 3 Hispanic 4 Other	Covariate
2018 BRFSS-Texas	Created from M21Q01 and M21Q02	Sexual and Minority Gender	1 LGBT 2 non-LGBT	Covariate
2018 BRFSS-Texas	C08Q07	What is the highest grade or year of school you completed?	1 Less than high school 2 High school graduate 3 Some college 4 College graduate	Covariate
2018 BRFSS-Texas	C08Q17	What is your annual household income from all sources?	1 Less than $25,000 2 $25,000 to less than $75,000 3 $75,000+	Covariate
2018 BRFSS-Texas	C03Q01	Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, government plans such as Medicare, or Indian Health Service?	1 Yes 2 No 7 Don't know/Not sure 9 Refused	Covariate

Appendix D: Research Question 4 Data Variables

Dataset	Variable	Question	Response	Type
2018 BRFSS-Texas	SEX	What is your sex?	1 Male 2 Female	Defines study population
2018 BRFSS-Texas	AGE	What is your age?	_ _ Age in years (18-99) 7 Don't know/Not sure 9 Refused	Defines study population
2018 BRFSS-Texas	C14Q07	*Have you had a hysterectomy?*	1 Yes 2 No 7 Don't know/Not sure 9 Refused	Defines study population
2018 BRFSS-Texas	C08Q09	In what county do you currently live?	_ _ _ ANSI County Code (formerly FIPS county code) 7 7 7 Don't know/Not sure 9 9 9 Refused	Independent variable
Create New	Create from C08Q09	Metro Status	1 Metro 2 Non-Metro	Independent Variable
2018 BRFSS-Texas	From C14Q03 and C14Q04	*Pap Test within past 3 years*	1 Yes 2 No	Dependent Variable
2018-2019 AHRF	PCPgroup	County Rate per 100,000	1 less than 55 per 100,000 people 2 between 55 and 75 per 100,000 people 3 more than 75 per 100,000 people	Covariate
2018-2019 AHRF	FQHCgroup	Number of FQHC per County	1 less than 7 2 between 7 and 9 3 more than 9	Covariate